

Dr. Martin Pall, PhD

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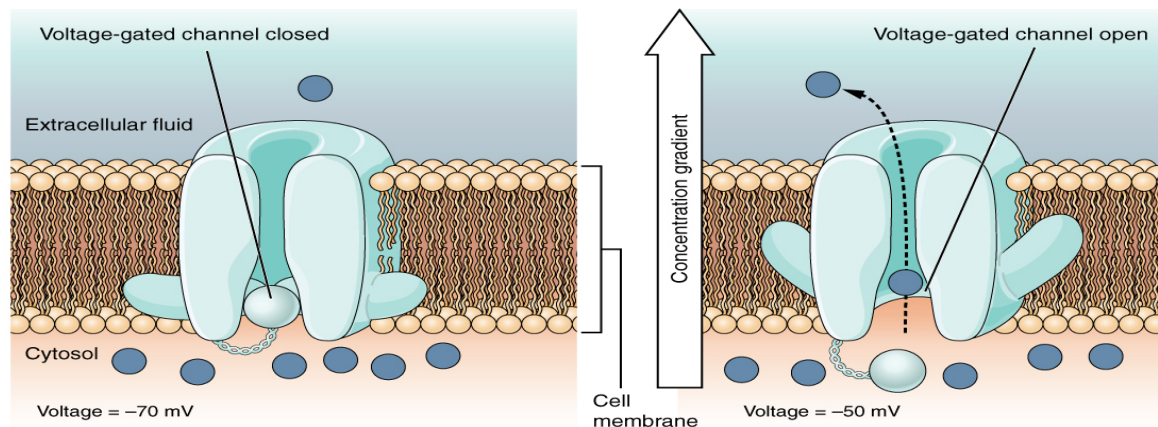
- Professor Emeritus Faculty in Biochemistry and Basic Medical Sciences
- Developing chronic fatigue led to MCS Research
- 8 int'l awards for work in environmental medicine & research into MCS mechanisms
- Developed interest in EHS research
- 2005 address to special session of EU parliament
- 2009 *J. of Gen & Applied Toxicology, 3rd Ed on MCS*
- 2013 paper *Mechanism of Action in EMF Exposure*
- 2014 of the *Jonathon Forman Award*, American Academy of Environmental Medicine



NIM

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- Thousands of papers show biological effects above international standards
- Substantial literature shows (*all*) EMF's activate the voltage gated calcium channels (VGCC) in the cell membrane & Increase intercellular Ca ions

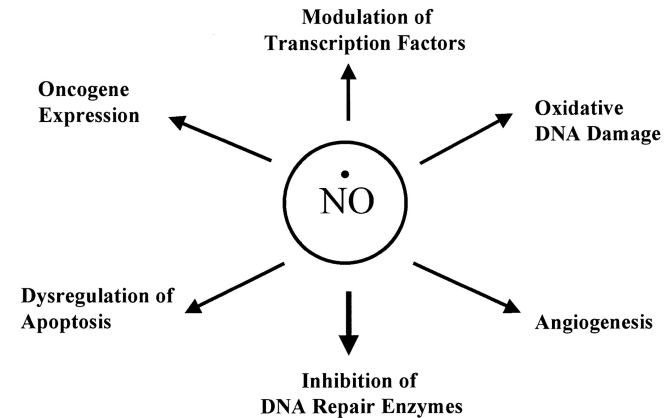


- Pulsed EMF's are much more bio-active than non-pulsed fields – 30 years
- This inconsistent with the thermal/heating paradigm
- Series of studies show effects can be blocked by calcium channel blockers

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- increased intracellular Ca can act to stimulate NO synthesis, such NO increases may also have an important role in biology & medicine
- *Pilla* showed that such low-intensity pulsed microwave exposures produce increases in both Ca²⁺ and NO synthesis in less than 5 seconds
- VGCCs have been shown to have a universal or near universal role in converting electrical effects into chemical changes in the cell

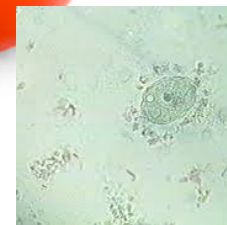


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- 100s of studies show low intensity microwave exposures are followed by changes in calcium fluxes and/or by changes in calcium signaling.
- 100s of studies show low-intensity microwave produce oxidative stress responses due to downstream effects of VGCC activation
- There can be no question that VGCCs are the major, perhaps the only targets of low intensity EMFs in the body.

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- Studies demonstrate weak EMFs activating VGCC-like channels in plants.
- Studies of tomato plants and tomato cells in culture show weak microwave fields activate VGCC-like channels and raise calcium signaling
- Effects were blocked by calcium channel blockers
- Strongly suggest weak microwave RF often activate VGCC-like channels in plants, acting similarly to the way such fields act in animals!



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- There can be no question that VGCCs are the major, perhaps the only targets of low intensity EMFs in the body.
- How VGCC activation act to produce biological changes in the body?

Most physiological responses to $[Ca^{2+}]_i$ and NO, act as follows:

NO increases levels of cGMP, leading in turn to stimulation of the cGMP-dependent protein kinase (protein kinase G).

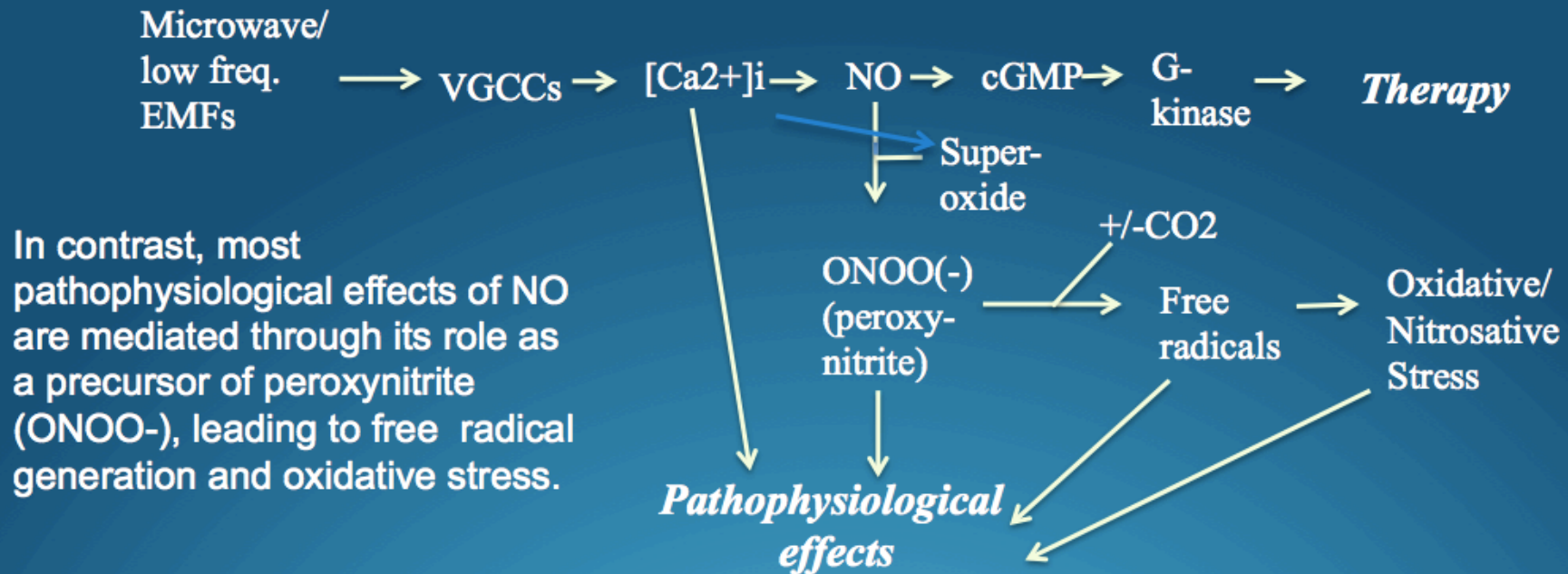


Table 1. Apparent Mechanisms of Action for Microwave Exposures Producing Diverse Biological Effects (See Fig. 1)

Reported Biologic Response	Apparent Mechanism(s)	Citation(s)/Comments
Oxidative stress	Peroxynitrite & consequent free radical formation	[1-3]; detected via a large number of oxidative stress markers
Single strand breaks in cellular DNA	Free radical attack on DNA	[1-3]
Double strand breaks in cellular DNA	Same as above	Same as above; detected from micronuclei and other chromosomal changes
Cancer	Single and double strand breaks, 8-nitroguanine and other pro-mutagenic changes in cellular DNA; produced by elevated NO, peroxynitrite	[3] and this paper
Breakdown of blood-brain barrier	Peroxynitrite activation of matrix metalloproteinases (MMPs) leading to proteolysis of tight junction proteins	[3]
Male and female infertility	Induction of double strand DNA breaks; Other oxidative stress mechanisms; $[Ca^{2+}]_i$ mitochondrial	[3]

Male and female infertility	Induction of double strand DNA breaks; Other oxidative stress mechanisms; $[Ca^{2+}]_i$ mitochondrial effects causing apoptosis; in males, breakdown of blood-testis barrier	[3]
Therapeutic effects	Increases in $[Ca]_i$ and NO/NO signaling	[1-3; 13]
Depression; diverse neuropsychiatric symptoms	VGCC activation of neurotransmitter release; other effects?; possible role of excess epinephrine/norepinephrine	These were reported in occupational exposures [21]; also reported in people living near cell phone towers
Melatonin depletion; sleep disruption	VGCCs, elevated $[Ca]_i$ leading to disruption of circadian rhythm entrainment as well as melatonin synthesis	[3]
Cataract formation	VGCC activation and $[Ca]_i$ elevation; calcium signaling and also peroxynitrite/oxidative stress	This paper
Tachycardia, arrhythmia, sometimes leading to sudden cardiac death	Very high VGCC activities found in cardiac (sinoatrial node) pacemaker cell; excessive VGCC activity and $[Ca^{2+}]_i$ levels produces these electrical changes in the heart	[3]

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Worse Case Scenarios- Autism

- The autism epidemic is probably largely caused by EMF exposures (although chemicals also have a role)
 - 32 different types of evidence support pathway of action from microwave exposure by disruption of synapse development
- US autism: one birth in 68 or 1.5% based 2002 data.
- With rapid increase in autism, the incidence in 2015 may be vastly higher
- In California, over a 11 year period, autism went up 16.6 fold. A similar increase of the 2002 birth levels would bring us up to about 25% of births.

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Worse Case Scenarios- Neuropsychiatric

Table 4. Commonly Reported Neuropsychiatric Symptoms following Microwave EMF Exposure

Symptom(s)	#s of studies reporting
Sleep disturbance/insomnia	16
Headache	15
Depression/depressive symptoms	11
Fatigue/tiredness	11
Dysesthesia (vision/hearing/olfactory dysfunction)	10
Concentration/attention/cognitive dysfunction	9
Memory changes	8
Dizziness	8
Irritability	8
Loss of appetite/body weight	8
Restlessness/tension/anxiety/stress/agitation/feeling of discomfort	6
Nausea	6
Skin tingling/burning/inflammation (dermographism)	6

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Worse Case Scenarios- Infertility

- Human male and female infertility & spontaneous abortion are increasing
- We know that these can each be caused by microwaves
- Most extensive evidence that male infertility is caused by microwave exposure (easiest to study) and that it is caused partly by oxidative/nitrosative stress
- Pairs of mice mated at two exposure levels within safety standards near a large numbers of broadcasting antennas went through only two generations (higher exposure) or four generations (lower exposure) before complete sterility

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Worse Case Scenarios- Alzheimer's

- There is an epidemic of premature Alzheimer's disease.
- Studies show occupational exposure to extremely low frequency EMFs increases Alzheimer's.
- Electromagnetic pulse exposure induces overexpression of beta amyloid protein (plaque) in rats. Arch Med Res. 2013 Apr;44(3):178-84
- The epidemic of premature Alzheimer's may be due to exposures 25 years ago when RF levels were much lower

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Worse Case Scenarios- Mutation

- Only 3 studies showing mutations in male germ line cells following microwave exposures, to my knowledge
- It is estimated that increasing our mutation frequency to 2.5 to 3 times the normal level ***will make us extinct***

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Cumulative Effects

- Longer exposures of a specific type often produce much more severe effects i.e. cumulative. Effects
- This was seen in:
 - Mouse infertility study discussed previously.
 - Occupational exposures studies from the 1970s.
 - Histological studies of changes in rodent brain structure
 - Brief exposures produced more modest effects
 - Effects largely reversed following cessation of exposure;
 - Prolonged exposure produced more severe and irreversible effects
- Cumulative effects on the human genome are also predicted for mutational effects.

Conclusions

- Strong support for cell level effects from RF and other man-made EMFs
- VGCCs has physical properties which predict that it is exquisitely sensitive to external EMFs
- Downstream effects of VGCC activation are:
 - Therapeutic effects
 - Oxidative stress;
 - Ca^{2+} flux/signaling changes
 - Cellular DNA strand breaks
 - Cancer
 - Diverse neuropsychiatric effects
 - Male and female infertility
 - Breakdown of the blood-brain barrier
 - Neuroendocrine effects including
 - melatonin deficiency
 - cardiac pacemaker effects leading to arrhythmia and sudden cardiac death.
 - “Sounds very much like hell on earth. Its highly plausible and perhaps highly probable”

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Lack of absolute certainty on the extent of these effects cannot be the basis for lack of vigorous action.

Putting us at great risk is completely unacceptable